[0005] METHOD AND APPARATUS FOR NUMERICALLY ANALYZING GRAIN

GROWTH ON SEMICONDUCTOR WAFER USING SEM IMAGE

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0010] The present invention relates to a method and an apparatus for analyzing

and evaluating a surface state of a semiconductor wafer, and more particularly, to a

method and an apparatus for accurately and quantitatively analyzing/evaluating a

growth state of grains on the surface of a semiconductor wafer, in which the grain

growth is automatically calculated using an image file of the surface of the

semiconductor wafer that is scanned by scanning electron microscopy (SEM).

2. Description of the Related Art

[0015] As semiconductor devices become smaller, the elements of the device, such

as a capacitor, also become correspondingly smaller.   Since the capacitance of the

capacitor is proportional to a surface area of a capacitor electrode, semiconductor

manufacturers and designers must somehow compensate for the reduced size and

capacitance of these smaller capacitors.   Accordingly, a focus of the manufacturing

process is to obtain a larger surface area for the capacitor electrode.

[0020] One typical manufacturing method for increasing the surface area of the

capacitor electrode is to grow hemispherical grains (HSGs) on a surface of the

capacitor electrode.   One particular manufacturing method increases the surface

area of the electrode itself by forming a one cylinder stack (OCS) – type capacitor

electrode on which the HSGs are grown.   The introduction of the OCS process

combined with the HSG process increases the surface area of the capacitor

electrode, thereby obtaining a large capacitance of the capacitor electrode.

[0025]   The surface area of the OCS-type capacitor is smaller in an upper distal portion thereof and larger along the sidewalls thereof.   During the manufacturing process for forming the OCS-type capacitor, the degree of HSG growth directly affects the ability to achieve a target capacitance, and therefore, a method for measuring a thickness of the HSGs is used and monitored.   However, that method is ineffective in those cases where a polysilicon thin film, on which the HSGs of a measurement test portion may be grown, is etched after introducing the OCS process.

[0030]   To overcome this problem, a method for measuring light reflectivity within a cell has been proposed, but this method suffers a drawback in that it lacks the ability to precisely discriminate between elements of the semiconductor device.

[0035]   Meanwhile, a scanning electron microscopy (SEM) method is widely used to precisely scan the surface state of the semiconductor wafer and analyze a manufacturing defect.   When used in conjunction with measuring the growth degree of HSGs on a semiconductor wafer, the SEM simply scans the growth state of the HSGs grown on the OCS-type capacitor and then displays a scanned image. Therefore, the operator must directly view the displayed image and determine the growth degree of the HSGs empirically.   As can be expected, such an empirical measuring method needs much time and effort, and additionally, it is difficult to accurately evaluate the quantitative growth degree of the HSGs because of the vagaries and inconsistencies inherent in a process involving human intervention.

SUMMARY OF THE INVENTION

[0040]   It is therefore an object of the present invention to provide a method and an apparatus for automatically analyzing a growth degree of grains on a surface of a

-2-

semiconductor wafer using image data generated by scanning the surface of the semiconductor wafer through a scanning electron microscopy (SEM).

[0045] In accordance with an aspect of the present invention, there is provided a method for numerically analyzing a growth degree of grains on a surface of a semiconductor wafer, including: selecting a numerical target zone in an image file for numerating the growth degree of grains on a specific portion of the surface of the semiconductor wafer, the image file being generated by scanning the specific portion on the surface of the semiconductor wafer using a scanning electron microscopy (SEM); performing a standardization with respect to an image data of respective pixels disposed within the selected numerical target zone to attain standardized image data values; comparing the standardized image data values of the respective pixels with a predetermined threshold value and counting the number of pixels whose standardized image data value is greater than the threshold value; and numerating the growth degree of grains on the surface of the numerical target zone by calculating a ratio of the number of the counted pixels with respect to the number of total pixels disposed within the numerical target zone.

[0050] In other aspects the image may be displayed on a monitor, and the operator may have the capability to designate different numerical target zones in the displayed image in order to numerate the growth degree of grains on specific portions of the surface of the semiconductor substrate.

[0055] Before performing the standardization with respect to the image data, a smoothing process may be implemented. The smoothing process smoothes the image data of the respective pixels disposed within the numerical target zone using an average value of image data of adjacent pixels in order to remove noise that may be caused when an analog signal is converted into a digital signal.

-3-